WE CLAIM:

1. A method of noninvasively measuring fluid density of a pulsed flow system with non-rigid vessel walls, comprising:

a) noninvasively measuring a local relative fluid volume ratio $V_b/\Delta V_b$, where V_b is a basal volume of fluid in a vessel and ΔV_b is a volume change of the fluid in the vessel due to the pulse;

b) noninvasively measuring a fluid pulse propagation velocity v ;

c) noninvasively measuring a basal fluid pressure P and a local change in fluid pressure ΔP;

d) calculating fluid density ρ_b as a function of the local relative fluid volume ratio, the fluid pulse propagation velocity, the basal fluid pressure, and local change in fluid pressure according to the generalized functional relationship

$F\left(\frac{\rho_b v^2}{\Delta P}\right) = G\left(\frac{V_b}{\Delta V_b}, \frac{P}{\Delta P}\right)$ or its derivatives.

2. The method of noninvasively measuring fluid density of Claim 1 wherein the fluid is blood.

3. The method of noninvasively measuring fluid density according to Claim 2, further comprising deriving a hematocrit value from the blood density.

4. The method of noninvasively deriving a hematocrit value from blood density of Claim 3 further comprising calculating the equation

$$Hct = \frac{\rho_b - \rho_{plasma}}{\rho_{bc} - \rho_{plasma}} \times 100$$

or its derivatives;

where ρ_b can be equal to $\left(\Delta P \times \frac{Y_b}{\Delta Y_b} \times \frac{t^2}{L^2}\right)$

where Hct is the hematocrit value,

ΔP is the difference between diastolic and systolic pressure,

$Y_b / \Delta Y_b$ is the ratio of the admittance of the blood in the artery before any pressure change to the change in admittance when the pressure is increased by ΔP,

t is the time it takes for a pressure wave to travel between the two displaced impedance channels that are a distance L apart,

ρ_b is the density of the blood,

ρ_{plasma} is the density of plasma, and

ρ_{bc} is the red blood cell density.

5. The method of noninvasively deriving a hematocrit value from blood density of Claim 4 further comprising using an average of mean reported values for ρ_{plasma} and ρ_{bc}.

6. The method of noninvasively measuring fluid density according to Claim 1, further comprising:

a) placing a coextensive pressure applicator and electrical impedance monitoring apparatus on a measurement area of a body;

b) applying a constant amplitude current to the measurement area;

c) applying pressure to the measurement area to remove blood therefrom;

d) measuring a change in impedance values of the measurement area while applying pressure;

e) measuring an arterial pulse pressure of the measurement area;

f) measuring a velocity of a pulse wave of the measurement area; and

g) deriving a blood density value from measurements of arterial pulse pressure, impedance, and velocity of pulse wave.

7. An apparatus for noninvasively measuring fluid density of a pulsed flow system with non-rigid vessel walls at a local measurement area, comprising:

a) means for noninvasively measuring a local relative fluid volume ratio $V_b/\Delta V_b$, where V_b is a basal volume of fluid in a vessel and ΔV_b is a volume change of the fluid in the vessel due to the pulse;

b) means for noninvasively measuring a fluid pulse propagation velocity v;

c) means for noninvasively measuring a basal fluid pressure P and a local change in fluid pressure ΔP; and

d) a calculator for determining fluid density ρ_b as a function of the local relative fluid volume ratio, the fluid pulse propagation velocity, the basal fluid pressure, and local change in fluid pressure according to the generalized functional relationship $F\left(\frac{\rho_b v^2}{\Delta P}\right) = G\left(\frac{V_b}{\Delta V_b}, \frac{P}{\Delta P}\right)$ or its derivatives.

8. The apparatus for noninvasively measuring fluid density of Claim 7 wherein the fluid is blood.

9. The apparatus for noninvasively measuring fluid density according to Claim 8, further comprising means for deriving a hematocrit value from the blood density.

10. The apparatus for noninvasively deriving a hematocrit value from blood density of Claim 9 further comprising means for calculating the equation

$$Hct = \frac{\rho_b - \rho_{plasma}}{\rho_{bc} - \rho_{plasma}} \times 100$$

or its derivatives;

where ρ_b can be equal to $\left(\Delta P \times \frac{Y_b}{\Delta Y_b} \times \frac{t^2}{L^2}\right)$

where Hct is the hematocrit value,

ΔP is the difference between diastolic and systolic pressure,

$Y_b / \Delta Y_b$ is the ratio of the admittance of the blood in the artery before any pressure change to the change in admittance when the pressure is increased by ΔP,

t is the time it takes for a pressure wave to travel between the two displaced impedance channels that are a distance L apart,

ρ_b is the density of the blood,

ρ_{plasma} is the density of plasma, and

ρ_{bc} is the red blood cell density.

11. The apparatus for noninvasively measuring fluid density according to Claim 7, wherein the means for noninvasively measuring a local relative fluid volume ratio, means for noninvasively measuring a fluid pulse propagation velocity, and means for noninvasively measuring a basal fluid pressure and a local change in fluid pressure, further comprise:

a) a coextensive pressure applicator and electrical impedance monitoring apparatus;

b) means for applying a constant amplitude current to the measurement area; and

c) means for measuring a change in impedance values of the measurement area while applying pressure.

12. The apparatus for noninvasively measuring fluid density according to Claim 7, wherein the means for noninvasively measuring a local relative fluid volume ratio, means for noninvasively measuring a fluid pulse propagation velocity, and means for noninvasively measuring a basal fluid pressure and a local change in fluid pressure, further comprise:

a) an impedance volume sensor;

b) an inflatable cuff pressure generator;

c) a pressure sensor, and

d) a monitor for determining volume states and pressure states and for controlling the application of pressure to the measurement area.

13. An apparatus for noninvasively measuring fluid density of a pulsed flow system with non-rigid vessel walls at a local measurement area, comprising::

a) a pressure applicator for applying external pressure to the local measurement area,

b) an impedance measurer coextensive with the pressure applicator; and

c) a calculator operably connected to the pressure applicator and the impedance measurer for calculating a fluid density value of the local measurement area.

14. The apparatus for noninvasively measuring fluid density of Claim 13 wherein the fluid is blood.

15. The apparatus for noninvasively measuring blood density according to Claim 14, further comprising a calculator for calculating a hematocrit value from the blood density value.

16. A method of noninvasively measuring fluid density of a pulsed flow system with non-rigid vessel walls, comprising:

a) noninvasively measuring a local relative fluid volume ratio $V_b/\Delta V_b$, where V_b is a basal volume of fluid in a vessel and ΔV_b is a volume change of the fluid in the vessel due to the pulse;

b) noninvasively measuring a fluid pulse propagation velocity v;

c) noninvasively measuring a local change in fluid pressure ΔP;

d) calculating fluid density ρ_b as a function of the local relative fluid volume ratio, the fluid pulse propagation velocity, and local change in fluid pressure according to the relationship $\frac{\rho_b v^2}{\Delta P} = \frac{V_b}{\Delta V_b}$ or its derivatives.

17. The method of noninvasively measuring fluid density of a pulsed flow system with non-rigid vessel walls of Claim 16 wherein the local relative fluid volume ratio $V_b/\Delta V_b$ is determined by:

a) measuring the electrical admittance (Y_b) of the basal fluid volume;

b) measuring the electrical admittance change (ΔY_b) due to increased local volume from pulsed flow; and

c) equating $\frac{Y_b}{\Delta Y_b} = \frac{V_b}{\Delta V_b}$, whereby the need to know the resistivity of the fluid in determining the local fluid volume ratio is eliminated.

18. A method of noninvasively measuring a local relative fluid volume ratio $V_b/\Delta V_b$ in a pulsed flow system with non-rigid vessel walls comprising:

a) measuring the electrical admittance (Y_b) of the local basal fluid volume;

b) measuring the electrical admittance change (ΔY_b) due to increased local volume from pulsed flow; and

c) equating $\frac{Y_b}{\Delta Y_b} = \frac{V_b}{\Delta V_b}$, whereby the need to know the resistivity of the fluid in determining the local fluid volume ratio is eliminated.

19. A method of determining a hematocrit value of blood comprising:

a) measuring density of the blood (ρ_b); and

b) determining the hematocrit value according to the relationship

$$Hct = \frac{\rho_b - \rho_{plasma}}{\rho_{bc} - \rho_{plasma}} \times 100 .$$